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**Review of Stock Assessments**
**For Loggerhead and Leatherback Sea Turtles**

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## Executive Summary

NMFSSFSC (2001) aims to provide the most updated documentation in assessing the stocks of loggerhead and leatherback sea turtles and impacts of pelagic longline fishery in the western north Atlantic. Separate status reports for the loggerhead and leatherback sea turtles have been developed based on the best available information.

Estimation methods used for trend, catch and mortality of these sea turtle stocks are appropriate. Per this data and the fact that U.S. longline fleets contribute a small amount of effort (hooks) we can not assert that the industry has had a significant detrimental impact on the aforementioned sea turtle populations or abundance rates.

The revised injury criteria and conclusions on stock status are reasonable. Further research on nesting behavioral, the likelihood of returning to a different site and the standardization of the search effort (for nesters) would be useful. Data on mortality rates from other possible sources should be collected and monitored. However, training and education programs would be helpful to improve the condition of hooked turtles.

## Summary of Information Reviewed

a. Documentation for F/PR review of post hooking mortality
b. Assessment of the impact of the pelagic longline fishery on loggerhead and leatherback sea turtles on the north Atlantic
c. Stock assessment of loggerhead sea turtle of the Western North Atlantic
d. Stock assessment of leatherback sea turtle of the Western North Atlantic
e. Revised estimates of bluefin tuna dead discards by the US. Atlantic pelagic bluefin tuna fleet 1992-1999[1]

[1] This document is provided because the method of bycatch estimation is a general method used not only for sea turtles but also for other bycatch like bluefin tunas. The consultant is to comment on the method in general and on its application to sea turtles specifically.

**Review of Available Information**

*Loggerhead and leatherback sea turtle of the Western North Atlantic*

The linear mixed model described in Appendix I was used to estimate the overall nesting population trends for loggerhead and leatherback turtles. Beach data were collected at a constant effort.(over several years for use in the analysis. The statistical model is appropriate.

Equal weight was given to each site; therefore the overall estimate of the trend from GLM is approximately the average of the individual trend for each site. It is important to note that this overall trend can be misleading. It does not take into account the relative abundance at each site. It is necessary to have information on relative abundance in each nesting site in order to obtain an unbiased overall trend for the population as a whole.

The simple average of the trend estimates from individual sites needs to be interpreted with caution because the relative abundance at different sites are not taken into consideration.
Without estimates of relative abundance, we can only limit our inference for individual sites.
The effects of TED need to be interpreted in a similar way. The estimates of the current trend (after TED)and their standard errors should be also presented because they represent the current status

*In-water surveys*

The analysis of In-water surveys using GLM appears reasonable. Two separate analyses were carried out using proportion of positive bycatch and positive bycatch rates. The criteria used in model selection are based on chi-square (likelihood ratio statistic) tests and reduction in deviance-per-degree-of-freedom (which essentially is an estimate of the model variance). After looking at the results in the tables closely, I realize that this is different than reduction-in-deviance per degree of freedom which is widely used in statistical analysis. Maybe a different name should be used to avoid confusion. The p-value for the chi-square test controlled at 5% may be too stringent. The reduction in deviance-per-degree-of-freedom criterion appears reasonable but it does not have known statistical properties. Threshold of 1% may be determined at discretion.

If I understand correctly, the second analysis using the positive bycatch rates used data only with turtle catches. If most of the catches from each positive trip were of either 1 or 2 turtles, the analysis would be very unreliable because of a lack of contrast. This may be different than tuna data in which the number of tuna from each positive trip may vary more widely. This is due to the fact that catching a turtle is relatively a rare event. Conclusions based on analysis using proportion of positive trips would be more appropriate.

The conclusion (p.12) is inaccurate: "unless the population was changing in size at about 25% per year, the SEAMAP monitoring program would not be able to detect a trend within the duration that it has been ongoing." My interpretation is as follows, Fixing the type I error at 20%, the power (the probability of detecting a change) at 25 is 0.9. That does not mean that say a change of 20% could not be detected but rather than the probability of detecting such change would be smaller than 90%, (e.g. 80% or 70%). To clarify this the power function in percent of change should be

evaluated, i.e., to evaluate the probability of detecting the difference assuming the true change rate is, for example, 5%, 10%, 15% and 20%. In any case it is not clear why the type I error was chosen at 0.2. Additionally it would be important to report the associated p-value of the estimated trend of 11.2%?

*Stock Assessment*

The stock assessment is based on the 5-stage structured model, requiring VB growth parameters and mortality rates. For growth parameters, data from mark recapture studies were used.

I have two questions here:

1. Is there any difference in growth between males and females? There is no mention about sex-specific growth parameters.

2. Are there multiple recaptures in the CMTTP data?

I cannot tell how the parameters were estimated from the CMTTP data. Female turtles might come to beaches to nest more than once over the study period. If available, multiple measures (i.e., observations from tagged turtles that have been recaptured more than once.) would provide more reliable estimates.

Sex Ratios for three sub-populations were obtained using information from three sites (Texas, North Carolina, and South Carolina). This method is reasonable. If natal origin proportions in Virginia are available, then ML estimates will be more reliable if developed using all available data, regardless of sample size. It is not clear if the current estimates in this report are consistent with Virginia data.

The benthic juvenile mortality-rate was estimated using stranded turtles. Apart from the assumption of stable age distribution, we also need to assume that the probability of being stranded (sampled) is independent of size (or age). If larger turtles are morelikely to be stranded, survival rate estimates will tend to be higher. Hence, this may be a source of bias in the estimates of mortality (they would be overestimated).
The adult survival rate was estimated at 0.812/yr (without separating out possible emigration rate). I agree this conservative estimate is the best one can do at this stage.

The population projection using three different elasticity values (exp(r)) in combination with other parameters was established to see the future stock trend. It is not clear why the change after TED (exp(r+r*)) was not used. I am skeptic about this result, as even a 30% reduction in mortality rate of small benthic juveniles may not be enough to stabilize the population.

I agree that more research is necessary to better understand the life cycle of leatherback turtles. In comparison to loggerhead turtles, the available information for leatherback turtles is sparse.

Effort data and spatial information from beach nesters should and can be collected

to model density and abundance of nests. Tagging experiments at multiple sites (Florida, French Guineas and Caribbean) may provide vital information on the possible nesting movement of leatherbacks.

It would also be useful to examine length-frequency data of tangled turtles before TED and after TED.

Satellite tracking combined with beach tagging may be considered to assess how often turtles nest and the likelihood of nesting elsewhere, in particular, the probability of nesting outside the study area.

*Post-Hooking Mortality*

The difference in non-successful tracks between the lightly hooked and deeply hooked (27% vs. 42% for loggerheads and 21.1% vs. 36.7% overall is striking although the difference may not have a p-value less than 5% due to the small sample size. It would be incorrect to assume there is no difference between the two estimtes based on the fact that the p-value is less than 5%. Because these turtles were given some kind of "best treatment," we would have expected their risk of death to be minimized.

The Mediterranean post-hooking study shows a mortality rate of 34.4% in captivity presumably after some treatment. I do not have a problem believing 34.4% as a minimum estimate for wild turtles with ingested hooks. However, I do believe that "well treated" turtles had a much better chance to survive comparing with those not well treated. Unfortunately there is no studies to evaluate such difference.

This leaves the question - what happens if they do not get a good treatment? (E.g. the monofilament line was left as long as 3 feet, which is probably the case in practice.) Training and education programs would be helpful in improving the condition of hooked turtles.
Is it possible to test the survival rate of a turtle with a monofilament line of 3 to 6 feet? If this is possible, I would recommend it. The results would be interesting and educational for all of us if indeed a 3-feet long line is deadly.

*Injury Criteria*

Injury classification is essential to assess the post-hook mortality accurately. Apparently, whether or not a turtle can survive after release depends on how serious the injury is, as indicated in the report. The development of guidelines to accurately assess the level of injury is crucial to obtaining reliable estimates of post-hook mortality. The interim guidelines are clearly a good start. The comments from reviewers with expertise in sea turtles and other marine mammals are particularly interesting and comprehensive.

Some additional research (such as using tag-recapture, aquaculture studies) may be carried out to obtain better mortality estimates. Mortality estimates obtained from such studies may be biased but parameters such as ratios of mortality rates for different categories will be more reliable. The revised criteria now offer 3 types: I. Non-serious injury, II. Minor/moderate injury, and III. Serious injury.

My suggestions are:

(1) Continue to carry out research (collect more data or analyze available data) to see if the induced mortality from type I and II injuries are the same and very small;
(2) To collect as detailed information as possible to further pin down the differences in mortality rates in post-hook mortality from type III injury. This may lead to subdivision of type III injury and hence obtain more accurate estimation of number of turtles died from injury.

If type I and II induce the same mortality rate, they may be merged as one type, while type III may be further divided into more distinct categories to differentiate future induced mortality rates.

Over the years, recapture data and possibly multiple recaptures from bycatch turtles may provide essential information on movement, natural mortality, and total stock size.

*Analysis of bycatch in longline fleet*

A pooling method (pooling across area or time until a minimum number of 30 observations in each stratum) is used. This method is intuitively attractive to avoid great uncertainties in strata with small sample sizes. However, it may not be an easy task to justify statistically. It would be more convincing if similar results can be obtained using different Nmin values (5 and 10, say). Nmin=5 in this case and Nmin=30 for bluefin tuna in a working document on revised estimates of bluefin tuna dead discards.

A systematic revision of missing locations and missing dates may need to be accounted for in the analysis. The revision is essentially imputing the missing values and assuming the imputed values are real observed. So the variances of the estimates would be inflated.The importance depends on the percentage of missing data. Little and Rubin (1987) may be a good reference for this.

Bycatch estimates were established using the Delta-lognormal model originally developed by Pennington (1983). This appears quite reasonable. The simple moment method (i.e., only use the first two terms in the G function) would provide reasonable estimates as well. The complicated expression used in the analysis is there to account for higher order terms arising from the lognormal model. If other distributions are used, these high order summation terms will have to be adjusted to obtain unbiased estimates. But like the moment estimates, they were all consistent (i.e., asymptotic bias is zero). (this previous sentence is unclear). In the report the alternative distribution of gamma was also suggested to replace lognormal. It should be noted that gamma and lognormal distributions are very similar when the mean and variance are matched. So in general, little difference can be found when a lognormal or a gamma distribution is used. Distributions other than gamma should be considered to investigate the implications of lognormal distribution assumptions (such as uniform and t-distributions after the log-transformation).

The GLM analysis for bycatch rate is nicely done. Spatial models may be considered for analysis of the catch-effort data. If data are not too sparse, spatial correlation patterns may be estimated to obtain more reliable estimates of total bycatches. However, due to high temporal variation, this may not be possible now, but it may be possible in the future.

**References**


Little, R. and Rubin, D.B. (1987). *Statistical Analysis with Missing Data*. John Wiley & Sons, Inc, New York

Pennington, M. (1983). Efficient estimators for abundance for fish and plankton surveys. *Biometrics* **39**: 281-286.

## APPENDIX I

## STATEMENT OF WORK

### Consulting Agreement Between the University of Miami and Dr. YouGan Wang

*General*

The highly migratory species (HMS) longline fishery interacts with sea turtle populations. Whether the impact of this interaction hinders the ability of sea turtle populations to achieve recovery has not been determined. To this end, the analyses evaluating the status of sea turtle stocks in the Western North Atlantic Ocean and estimates of mortality from the HMS longline fishery need to be reviewed independently.

Separate status reports for the loggerhead and leatherback sea turtles have been developed based on current information on stock structure. Estimates of catch and mortality for these sea turtle stocks have been developed and included in the status reports. The impact of these mortality estimates has been evaluated. If it is found that this mortality is affecting recovery trajectories and impeding recovery, reductions in mortality have to be developed and evaluated to ensure recovery. Recovery trajectories must be based on the existing criteria included in the current Recovery Plans for these stocks.

The South East Region (SER) must develop mitigation plans and a biological opinion on the effects of these plans on sea turtle recovery. As the mitigation plan and Biological Opinion may recommend changes to the fishery, the consultant shall review the analyses supporting the Mitigation Plans and Biological Opinion to determine whether they represent the best available science/information.

The consultant shall review the stock assessments for loggerhead and leatherback sea turtles, focusing on the following:

1. Assumptions made defining stock structure including their correspondence with genetic information;

2. Application of serious injury criteria;

3. Estimation procedures for catch and mortality in the longline fishery;

4. Conclusions on stock status and impacts of fishery relative to stock recovery.

The consultant shall conclude, in a written report, whether the analyses represent the best available scientific information on which to proceed with fishery management.

*Specific*

The consultant's duties shall not exceed a maximum total of nine (9) days- several days for document review and several days to produce a written report of the findings. The consultant may perform all review, analysis, and writing duties out of the consultant's primary location, as no travel is required.

The itemized tasks of the consultant include:

- Reading and reviewing the following documents provided to the consultant:
    - Documentation for F/PR review of post hooking mortality
    - Assessment of the impact of the pelagic longline fishery on loggerhead and leatherback sea turtles on the north Atlantic
    - Stock assessment of loggerhead sea turtle of the Western North Atlantic
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    - Revised estimates of bluefin tuna dead discards by the US. Atlantic pelagic bluefin tuna fleet 1992-1999[2]

- Determining if the methods applied to estimate bycatch is appropriate given the available data. In this element, reviewers are expected to recommend improvements in methods for estimating the associated precision in estimates of bycatch. Reviewers are also expected to recommend improvements in data collection that could lead to more accurate and precise estimates of bycatch.

- No later than March 5, 2001, submitting a written report of findings, analysis, and conclusions. The report should be addressed to the "UM Independent System for Peer Reviews, " and sent to Dr. David Die, UM/RSMAS, 4600 Rickenbacker Causeway, Miami, FL 33149 (or via email to ddie@rsmas.miami.edu).

Signed

Date: March 5, 2001

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## ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report should be prefaced with an executive summary of findings and/or recommendations.

2. The main body of the report should consist of a background, description of review activities, summary of findings, and conclusions/recommendations.

3. The report should also include as separate appendices the bibliography of materials provided by the Center for Independent Experts and the center and a copy of the statement of work.

4. All material provided to the reviewer must be added to the bibliography that can be returned as an appendix to the final report.

Please refer to the following website for additional information on report generation: http://www.rsmas.miami.edu/groups/cimas/Report_Standard_Format.html